

The Behavior and Social Relations of the Gibbon (*Hylobates lar*) Observed under Restricted Free-range Conditions

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(Text-figures 1 & 2)

FIELD studies of animal behavior have a long and honorable history in comparative psychology. There have been, however, relatively few attempts to correlate data gathered in natural habitats with laboratory studies of behavior in the same species. The activity of laboratory animals has been assumed to be characteristic of a species despite the restrictions of the laboratory and the effects of selective breeding. Until Calhoun's (1950) research on the behavior and demology of the free-ranging albino rat, little was known of the social behavior of this rodent under simulated natural conditions. The significance of the fact that all Syrian hamsters, *Cricetus aureus*, derive from a few pairs captured in Syria, has not been apparent in the laboratory studies of the behavior of this mammal. The influence of selective breeding and long years of laboratory life can be appreciated and evaluated only by matched field and laboratory investigation. Richter (1954) has shown that there is structural and glandular change in rats after domestication. Riess (1950) has pointed to other areas in which comparative field and laboratory research would be helpful.

When interest centers on social psychological investigations, it is generally agreed that such studies should be undertaken under conditions optimal for the development of inter-individual behavior. The naturalist Hediger (1942), among others, has emphasized the important influence of "territoriality" on the social groupings of infra-human species. So, too, Colias (1950) has shown the relationship between dominance and

environment to be one determinant of social behavior. Despite the growing awareness among comparative psychologists of the importance of the processes in the concept of territoriality, we still lack basic studies of social behavior in systematically varied levels of environmental restriction. For instance, the effect of sound-induced seizures in rats may be a function of the size of the auditory enclosure within which the rat lives. By and large, for most laboratory subjects in comparative psychology, ecological-psychological description of their behavior under non-laboratory or natural conditions is very sparsely represented in the literature.

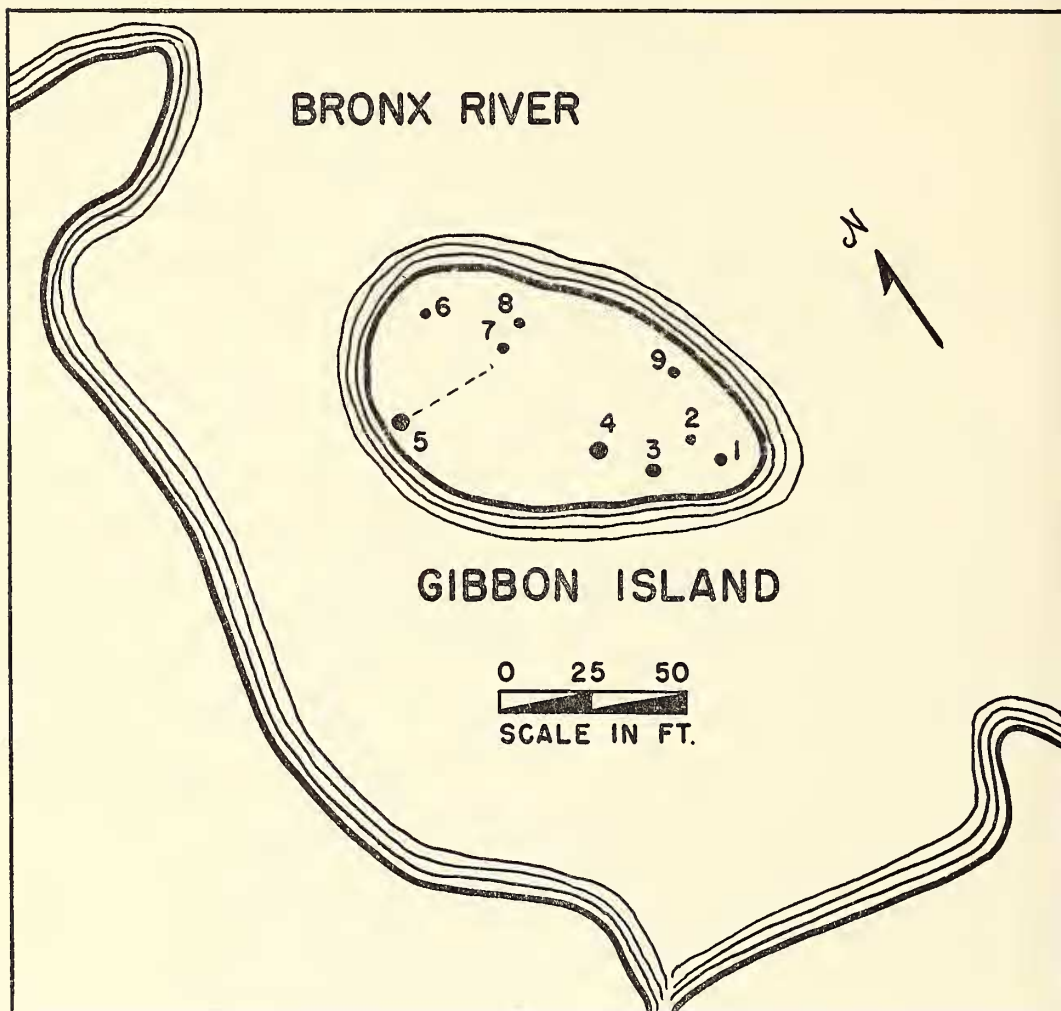
The author participated for several years in a program designed to evaluate the research possibilities in the zoological collections of living material at the New York Zoological Park (Bronx Zoo). Here, for certain species, it was possible to obtain data based upon observations of animals in environments of variable size, ranging from large compounds of several acres to small cages. Several studies based on the work at the Bronx Zoo have already appeared to validate the usefulness of the project.²

The present paper is a study of a family of gibbons of a species whose behavior in its natural habitat has been systematically described by Carpenter (1940). Comparison of free-range behavior with that in a relatively restricted captive territory was felt to offer opportunities for the evaluation of the effect of territoriality and other factors on social activity. Furthermore, since the family of gibbons to be studied was exhibited over a number of years under similar conditions, long-range observations could be made.

Subjects and Habitat.—The animals observed were a family of gibbons, *Hylobates lar*, native to the Burma region. The gibbon is usually placed by taxonomists within the anthropoid ape group. According to Carpenter (1940), their

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² Success of the project was largely owing to the splendid cooperation of the staff and keepers at the Park. Special appreciation is extended to Drs. Fairfield Osborn and John Tee-Van and Messrs. Lee S. Crandall, William Bridges, Gordon Cuyler and Quentin Schubert of the staff of the Zoological Park.



TEXT-FIG. 1. Map of Gibbon Island in Lake Agassiz, Bronx River, New York Zoological Park.

social organization is characterized by small family groupings ranging in size from two to eight animals. The group under observation at the New York Zoological Park originated from a male and female, fully adult at the time of this study, which were obtained from a dealer in 1942. A mating occurred and produced a male offspring in June, 1946. Subsequently, in 1948 and 1950, young were again produced, male and female respectively. During both summers of my tenancy of the research fellowship, the family consisted of the parents and first one and then two young animals.

During the winter the family lived as a unit in a large cage in the Primate House. It was on exhibition from 10 A.M. to 5 P.M. during the week and somewhat later during week-ends. During the summer months, from June to September, the gibbons were exhibited on Gibbon

Island, a small, circular body of land in Lake Agassiz at the north end of the Park. Text-figure 1 shows the general topography of the island. It is separated from the mainland by a narrow channel approximately 30 feet wide. Vegetation consisted of nine trees of various heights, maples, oaks and plane trees, growing amid grass and weed. The only artifact on the island was a guy wire running from Tree #5 to the ground. At the tree, it was about 15 feet above ground level and ran 20 feet to its termination in a stake in the ground.

The gibbon family was the only regular mammalian exhibit on the island. Various aquatic birds made their homes in and around the lake and shore and came to the island for remnants of food dropped by the apes. Flocks of wild Canada geese and some ducks also dropped in on the island in their fall migratory flights.

Routine feeding of the apes took place between 11:30 A.M. and 12:30 P.M. daily. The keepers tossed food over the water gap to the foot of Tree #5 where the gibbons would pick it up and carry it to the limbs of the trees. Diet consisted of half loaves of bread, whole cabbages, heads of lettuce, carrots, beets, turnips, oranges, apples and bananas.

Observational Procedures.—The gibbons were studied by the author for varying periods of time each day for a total of 115 days during June, July, August and early September of 1947 and 1948. The periods ranged from one to five hours. Summer observations were systematically scattered so that each hour of the day between 6:00 A.M. and 9:00 P.M. was covered at least twelve times in the two summers. In addition, five full days were devoted to dawn-to-dusk study in order to obtain continuous activity data. Observations were also made irregularly while the animals were in winter quarters in the Primate House.

All observations were made from a rocky eminence on the west shore of the lake, opposite the island at the narrowest part of the water gap. The elevation of the observation post was approximately equal to the height of the mid-section of Tree #5 in which the animals spent most of their time. From the vantage point of the rock, the entire island could be observed and with a little practice in the detection of concealed members of the family, the behavior of the apes could be brought under close scrutiny. A pair of field-glasses (8×30), a stop watch and an automatic counter were used to obtain the data of this report.

Results.—The quantitative data obtained from the gibbon family on Gibbon Island will be presented at a later point. While meaningful in themselves, the present results take on additional significance when interpreted against the background of Carpenter's (1940) observations on the same species in the wild in Thailand. From the latter's monograph, the following statements have been abstracted so as to give a concise picture of *Hylobates lar* under free-ranging conditions.

A. Family Structure.—Gibbons exhibit a pattern of family grouping consisting of parents and two to four young ranging in age estimated at two to six years. Solitary animals of both sexes are found on the periphery of the family group. Semi-solitary individuals of early adult status may pair to form the nucleus of a new family organization. Within the family, the sexes are equi-dominant where dominance is defined in terms of access to incentives involved in feeding, sexual activity, grooming positions and group-coordinating behavior.

B. Inter-individual Behavior.—Copulation was infrequently observed and was seen on only two of several hundred observation periods. In both instances, the female was the more active of the pair. Presentation and genital inspection were rarely observed.

Male-young relationships were characterized by inspection and grooming by the father while the young were in the infant stage of development. As the young animals matured, some play with the parent was observed and males were seen to "guard" the offspring when alarm calls were sounded. Further maturation of the young led to overt hostility between the older male and the developing young.

Female-young interaction starts with the nursing and carrying of the young by the mother. Infants were almost invariably placed on the mother's belly where the female could cover them with her arms and legs. Riding pick-a-back was never observed. Considerable inspection and grooming were found. It is Carpenter's impression that the relationship between mother and young depicted above is commoner among gibbons than among other observed groups of simians or apes.

Young-young relations are somewhat overshadowed by the dominant familial pattern of parental interaction with the young. Infant animals give evidence of a tremendous amount of play by themselves. Play was maximal during the early morning and during the afternoon period of parental quiet.

C. Territoriality.—The amount of territory covered by a group in its native habitat depended on (1) the number of animals in the group; (2) size and kind of forest; (3) competition from other groups; (4) availability of nutrition; (5) disturbance by human beings or "enemies"; (6) optimal conditions of environment such as humidity and temperature; (7) previous adaptation; (8) pressure from other gibbon groups. It was roughly estimated that the territory ranged from 30 to 100 acres for various groups of gibbons in Thailand. It should be kept in mind that extent of territory is related to the three-dimensional structure of the life-space of the species. Where trees are tall and dense, area tends to be more circumscribed than otherwise. Territory is fairly rigorously defended and defined, sometimes by overt aggression but more frequently by vocalization. Within the territory, gibbons preferred the midportions of trees rather than the tops or bases. They were strictly arboreal and rarely came to the ground except during the dry season for water.

D. Social Behavior.—Gestural activity was found to be an important factor in the social life of the gibbon in the wild. Grimaces, lip and eye

TABLE 1. OCCURRENCE OF INTER-INDIVIDUAL BEHAVIOR

Type of Behavior	1947						1948					
	Male with		Female with		Young ₁ with		Male with		Female with		Young ₁ with	
	Fe	Y ₁	M	Y ₁	Fe	M	Fe	Y ₁	M	Y ₁	Fe	M
<i>Sexual</i>												
Genital Inspection	1	..	2	..	..	..	3	..	2	..	..	..
Presentation	..	..	1	..	..	..	..	..	4	..	..	..
<i>Grooming</i>												
Frequency	25	8	37	11	5	6	18	6	43	15	10	16
M'n. Duration (in secs.)	80	12	30	110	24	14	58	30	45	96	38	21
<i>Fighting</i>												
Frequency	..	2	..	..	4	..	..	..	..	..	..	..
<i>Play-chasing</i>												
Frequency	85	19	101	26	12	16	42	..	118	36	59	48
M'n. Duration (in secs.)	80	65	150	105	57	76	70	..	175	90	120	80

movements and gross motor manifestations tended to fall into patterns which were specific to certain situations. Greeting after separation or upon the inception of group action, angry gestures and fighting positions constituted the most commonly observed patterns.

Vocalization is a mode of social interaction and such communication serves coordination among gibbon groups to an extent rarely found in other primates. Through the use of parabolic reflectors and disk recorders, Carpenter was able to differentiate nine types of calls and to describe the situations eliciting them. The two most frequent were (1) a series of hoots of rising pitch and intensity, and (2) single, discrete notes, sometimes in repeated series. Type 1 seemed associated with exploration, defensive action and protection of territory. It was more frequently emitted by females and never by the young. Type II served to localize territory and to avoid inter-group conflict over the range. It was predominantly an adult male call. The peak of vocalization fell in the early morning hours between 7:30 and 9:00 A.M. with a secondary rise in late afternoon. Both of these periods coincided with the maximum movement behavior of the group.

Aggressive behavior seemed to be a minor factor as observed in the life of the organized gibbon group. Vocalization represented a kind of substitutive activity for fighting. Unlike captive animals, wild gibbons were never seen in actual combat. This may be the result of pre-established patterns of dominance status. Inter-species hostility was less than intra-species.

Dominance and grooming are usually found to be concomitant variables in studies of primate and simian groups. In the gibbon, where equi-dominance of male and female seems established, grooming by others and by self were almost equally frequent. Grooming was relatively common and definite evidence of consistent initiation by a given animal was wanting.

With this background, the material presented in Tables 1, 2 and 3 offers a basis for certain limited generalizations about the effect of captivity, restricted range and lack of pressure from other groups on social behavior. Table 1 lists the frequencies for behavioral items involving inter-individual contacts, such as sexual activity, grooming, fighting and playing. One exception has been made in the inclusion of inter-individual items in Table 1; eating, whether individually or in groups, has been located in Table 2, together with other forms of individual activity. Frequencies in all cases are expressed in absolute terms and represent the cumulative occurrences of the behavior in question in approximately 100 hours of observation per summer.

TABLE 2. OCCURRENCE OF INDIVIDUAL BEHAVIORAL ITEMS

Behavior	1947			1948			
	Male	Female	Young ₁	Male	Female	Young ₁	Young ₂
<i>Eating</i>							
When alone	148	196	205	120	115	170	2
With one or more of family	60	75	39	105	127	162	104
On ground	19	24	6	22	19	16	..
On trunk	86	102	151	54	80	87	49
On limbs	103	145	87	149	143	229	57
Food taken from							
male by	..	14	18	..	42	40	..
female by	12	..	66	26	..	3	86
young ₁ by	..	20	..	15	37	..	..
<i>Resting Position</i>							
On wire	86	72	101	90	70	88	..
Tree #1	4	6	..	6	10	2	..
#2	3	10	2	2	4	4	..
#3	2	1	0	2	1	1	..
#4	12	5	4	10	7	16	..
#5	572	521	516	566	626	582	16
#6	202	198	175	187	115	110	..
#7	212	201	121	156	132	187	..
#8	101	142	262	181	108	190	..
#9	18	26	31	20	15	28	..
<i>Position when in Tree #5</i>							
At top	16	46	318	15	66	253	..
In middle	156	288	90	212	389	180	16
On side limbs	214	82	34	157	69	61	..
On trunk	186	105	74	182	102	88	..
<i>Brachiation</i>							
M'n. time/hr.	18'	31'	9'	16'	34'	21'	..

No attempt has been made to plot frequencies against diurnal variations. Where conclusions as to distribution over certain hours of the day can be drawn, they will be stated textually.

It will be seen from the data in Table 1 that the family on Gibbon Island in the Bronx Zoo has certain specific resemblances to the behavior of animals in Thailand as reported by Carpenter. Sexual activity is infrequent, an observation which was made for gibbons as long ago as 1771 by Turpin. Since the gestation period is variously estimated at seven months (Yerkes, 1929) and births have been noted from May through June, it may be that the summer season is not propitious for the observation of sexual behavior. What activity did occur was exclusively between the two adult members of the group and was equally divided as to initiation between the male and the female. The increase in frequency of both inspection and presentation during the second summer as compared with 1947 is noteworthy, but its etiology is unknown.

Grooming has usually been assigned a place

as a determinant of that vague construct known as dominance. In the gibbon, as comparison of Table 1 and 2 shows, "self" and "social" grooming occur with almost equal frequency. However, when inter-individual grooming is considered alone, family relationships seem to stand out as important determinants of the frequency of occurrence of this type of behavior. Both the absolute amount and the duration of grooming of family members by the male adult increased as the size of the family became greater. This increment holds true also of the female and to a lesser extent of the older offspring. The absence of self or social grooming by the most recent family member may be related to the prolonged period of biological dependence of the gibbon infant upon its mother.

The distinction made in the next two categories, fighting and play-chasing, is somewhat subjective. Real aggression with injury to one or more gibbons was never seen during either summer period of observation.

From Carpenter's data on collected speci-

TABLE 3. TYPE AND FREQUENCY OF VOCALIZATION PER HOUR OF THE DAY

Time of Day	Male				Female				Young ₁			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
6-7 '47 Mn.	2.4	2.1	..	2.2	2.5	1.0	..	1.6	1.0	..	..	3.0
A.M. '48 Mn.	2.8	3.0	..	2.1	2.2	1.5	..	1.4	2.3	1.8	..	1.9
7-8 '47 Mn.	2.8	3.6	..	2.4	2.4	2.1	..	1.8	1.0	1.0	..	2.4
A.M. '48 Mn.	2.6	3.5	..	1.9	2.7	2.0	..	1.7	1.1	2.0	..	1.7
8-9 '47 Mn.	2.6	3.5	..	1.5	3.0	2.8	..	..	3.5	1.8	..	1.0
A.M. '48 Mn.	2.5	3.3	..	1.0	3.4	2.1	..	.5	4.2	1.7	..	1.9
9-10 '47 Mn.	2.0	1.5	..	..	2.6	1.4	..	..	..	..	..	..
A.M. '48 Mn.	1.5	2.1	..	.7	3.1	1.3	..	..	2.6	1.0	..	..
10-11 '47 Mn.	1.6	1.2	1.0	..	2.0	1.0	1.0	..	..	..	..	..
A.M. '48 Mn.	1.8	1.9	1.1	..	1.9	1.4	1.0	..	.5	1.8	1.0	..
11-12 '47 Mn.	1.4	4.2	2.8	..	4.5	2.0	1.7	..	2.8	2.0	..	..
A.M. '48 Mn.	1.9	4.3	2.5	..	4.1	2.3	1.2	..	2.0	4.0	1.1	..
12-1 '47 Mn.	1.4	3.9	1.0	..	4.5	1.5	1.1	..	2.1	1.9	..	..
P.M. '48 Mn.	1.2	4.0	1.0	..	4.7	1.3	1.0	..	1.6	3.9	1.0	..
1-2 '47 Mn.	..	..	..	..	..	1.0	..	..	..	..	..	..
P.M. '48 Mn.	..	..	..	..	..	..	..	..	..	..	..	..
2-3 '47 Mn.	..	..	..	..	..	..	..	..	..	..	..	..
P.M. '48 Mn.	..	..	..	..	..	..	..	..	..	..	..	..
3-4 '47 Mn.	1.0	2.1	..	..	2.0	1.8	..	..	..	..	..	..
P.M. '48 Mn.	1.3	3.0	..	..	3.7	2.3	..	..	..	3.0	..	..
4-5 '47 Mn.	..	..	1.4	1.8	..	..	1.7	1.6	..	..	1.6	..
P.M. '48 Mn.	..	..	1.3	1.0	..	..	1.5	1.7	..	..	1.7	1.4
5-6 '47 Mn.	..	..	1.0	1.0	..	..	1.0	1.0	..	..	..	..
P.M. '48 Mn.	..	..	1.1	1.7	..	..	1.3	1.6	..	..	.9	1.2
6-7 '47 Mn.	1.5	3.2	..	..	3.1	1.5	2.0	..	2.2	2.0	..	3.0
P.M. '48 Mn.	1.8	3.8	..	1.0	4.0	1.7	1.9	..	1.6	3.4	..	..
7-8 '47 Mn.	1.0	2.6	..	..	2.6	1.0	1.5	..	1.8	2.5	..	2.5
P.M. '48 Mn.	1.4	4.3	..	..	4.6	1.1	1.0	..	1.5	3.5	..	..
8-9 '47 Mn.	..	..	..	2.0	..	..	..	2.0	..	..	..	1.8
P.M. '48 Mn.	..	..	..	3.0	..	..	..	2.5	..	..	..	1.1
Total Mean '47	1.2	1.8	.5	1.0	2.0	1.1	.6	.6	.9	.7	.1	.9
of Means '48	1.2	2.3	.4	.8	2.3	1.0	.6	.6	1.1	1.6	.4	.6

mens shot in the wild, it would appear highly doubtful that the gibbon is as non-aggressive as our observations would imply. Examination of these specimens shot in Thailand showed numerous scars, wounds and fractures despite the failure of the author to see any actual fights. That the gibbons on Gibbon Island can be aggressive to human intervention is attested by many incidents related by their keepers. However, what the animals do relative to human beings cannot be directly carried over to intra-species behavior.

All in all, only six instances of fighting were observed at the Zoo. In these, the most outstanding fact was vocalization seemingly of Carpenter's Class III. Overt aggressive movement was present but not actual physical contact. All the six incidents involved the older of the two young

animals and were relatively mild in nature and short in duration. The mother was attacked four times, while fighting was initiated by the father on two occasions. Competition for food was the precipitating stimulus for each behavior.

The activity called play-chasing describes a sequence of brachiations initiated by a member of the family and then taken up by one or more additional members. Although the paths of the initiator and the other animals were in general alike, there was by no means use of identical branches in swinging through the trees. However, the direction of progression was always the same. Typically such behavior ended with the initiator coming to a halt on one of its preferred resting places and the followers then seeking theirs. Here, too, there was an increase in fre-

quency during the second summer, as the second youngster became a member of the group. Whether the increase represents the effect of increased maturity of the young or social facilitation by a larger group is not clear. One final note on play-chasing is worth recording. The duration of each play-chasing sequence is relatively short but the distance covered during the behavior was considerable. A rough estimate of space covered would certainly set it at several hundred feet.

Table 2 indicates the growing socialization of familial patterns during the second summer. For instance, the number of times that eating in groups was observed was substantially greater in 1948 than in 1947. So, too, the locus of feeding activity shifted from the trunk to the favorite resting place in the limbs where groupings were possible. Increase in food exchange also marked the development and growth of the family.

Tree #5 was used most often as a resting place. This was undoubtedly the result of the fact that it was the place where food was thrown across the water gap by the keepers. Foci of sociality were thus established within the territory. In general, the trend of the two summers was to bring the family units closer together spatially as well as behaviorally. This was illustrated by the frequency of the positions assumed by the young ape during the summer. There was an increase in the use of Tree # 5 and a decrease in the use of isolated positions elsewhere with the exception of Tree # 8. This latter resting place was favored by offspring I as indicated by the fact that this animal's aggressive calls of Type III occurred when the parent animals brachiated into the tree. Tree # 8 was also frequently approached by the first offspring when walking upright on the ground.

Territoriality in the gibbon is a three-dimensional affair in which elevation from the ground operates as a selective factor. As can be seen in next to the last part of Table 2, the top branches were almost exclusively favorite resting places for the young animal, whereas the middle limbs in the center of the tree were used by the mother, and the peripheral, middle-height limbs were frequented by the father. The capacity of the branches to sustain the weight of the animals was not the decisive factor in the selection since the resting places of the father and offspring were about equally thick.

Vocalization is an activity of gibbons which universally excites curiosity and speculation among observers of the species. As Carpenter remarks "the coordination and control of gibbon families is carried out by complex systems of gestures and patterns of vocalization." The variety of calls, their recurrence in well-marked

patterns as well as their carrying power, make an important area of research. In our observation of vocalization, Carpenter's classification system has been used. However several types of calls noted by him were so rarely found in our animals that they have been omitted. Indeed, this may be one of the marked effects of the living situation out of the total biotic context, especially away from other families. Four patterns composed the great majority of calls at the Bronx Zoo. These can be described as follows:

Type I (Carpenter and Riess)—A series of hoots with rising inflection, rising pitch and increasing tempo with a climax followed by two or three notes of lower pitch. Duration was usually between 12 and 30 seconds.

Type II (Carpenter and Riess)—Single, discrete calls in series, which may be repeated over and over.

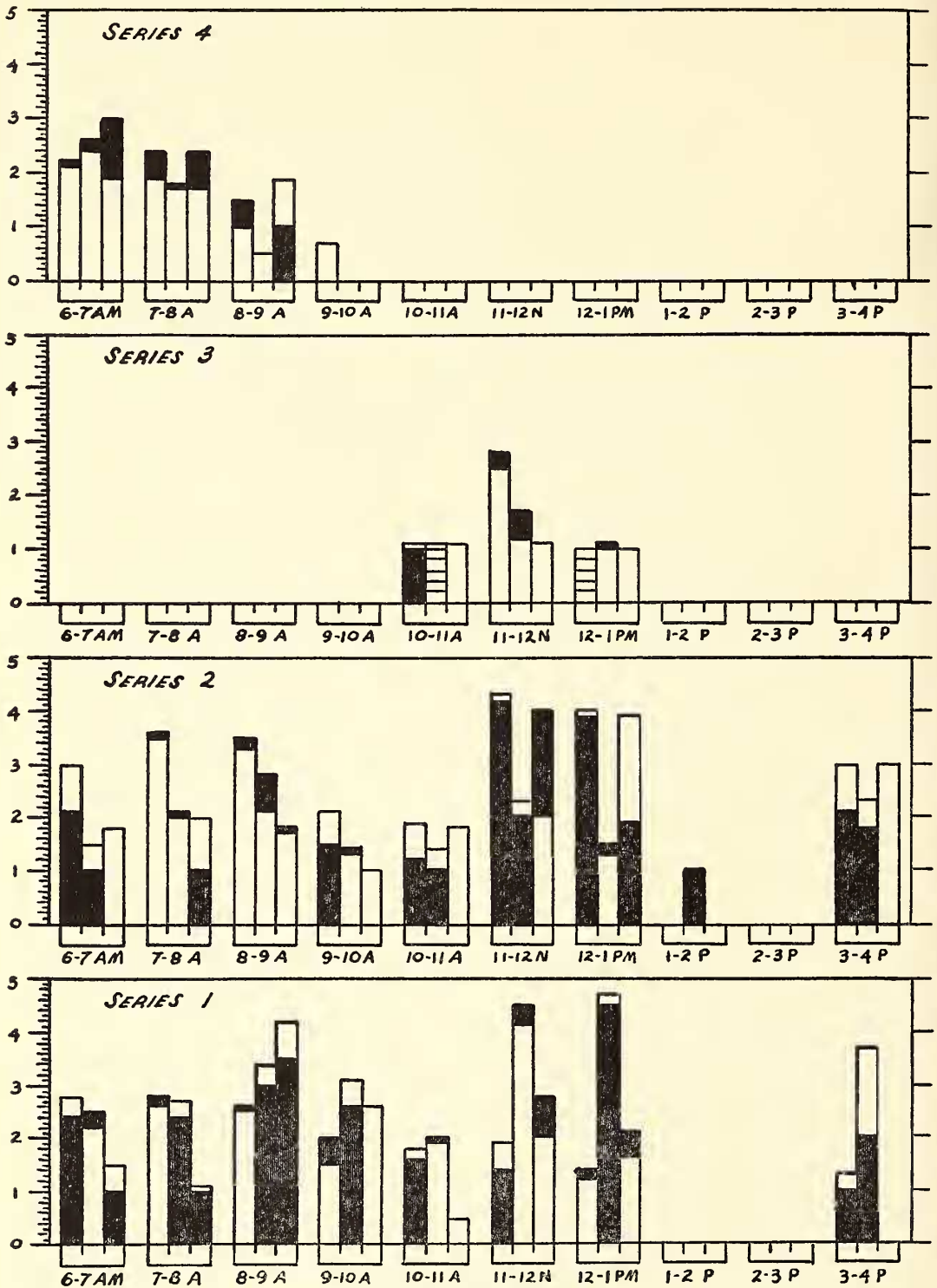
Type III (Carpenter and Riess)—Loud, high-pitched single note.

Type IV (Carpenter's Type VIII)—A fretting cry.

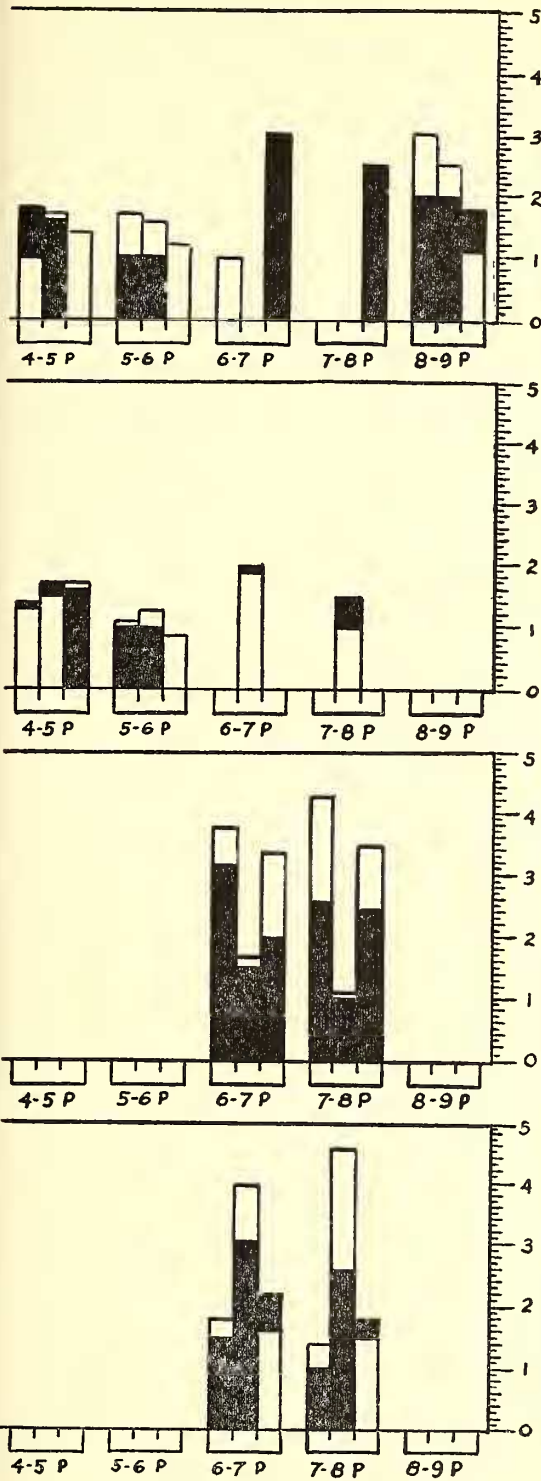
In studying this aspect of social behavior, several questions presented themselves. First, how did the various types of calls distribute themselves over the diurnal activity cycle of the gibbon? Second, were the differences in the types of calls given by various members of the family specific to the individual caller? Third, as increasing familialization took place, were there changes in a given type of call? The objective measurement of calls was difficult and it was decided to use Carpenter's lead in setting up a frequency count. During each period of observation, the observer tried to indicate the frequency of each type of call on a tally sheet previously prepared. At the end of each session, these frequencies were converted into points on a five-point scale in which 1 denoted maximum frequency.

Table 3 and the accompanying graphs (Text-fig. 2) summarize the findings. In terms of over-all ranks, it is clear from the last two rows of the table that there were evident differences in the use of various calls by the gibbons under observation. The male adult in both summers used Type II predominantly, whereas the mother used Type I. Offspring # 2 shifted from Type I in the summer of 1947 to Type II in 1948. What this represented was not clear from any data available.

Each of the four graphs in Text-fig. 2 represents one type of call. Within each type, the first column for any hour of observation records the frequency of the responses by the adult male,



TEXT-FIG. 2. Types of vocalization related to hour of the day, the animal emitting the call, and to each summer of observation. Each series describes one type of vocalization. The first column in each group of bars refers to the male adult, the second to the female adult, and the third to the first-born offspring. Bars in solid black refer to observations made in 1947, and those in outline to observations made in 1948.



the second by the female and the third column by the older offspring. This presentation, in a way, illustrates the value of comparison of field and restricted range data since it is possible in the latter to correlate behavior with known individuals, a technique difficult if not impossible in the field. Black areas in the figure show the data for 1947 and light areas for 1948. Where the scores for the first summer are higher than for the second, the column will be light at the base and dark on the upper part. The cycles in diurnal frequency stand out clearly in the graph. All types of calls diminish to the vanishing point after 1:00 P.M. This is generally also a time of motor inactivity, following as it does upon the noon feeding period.

Considering the calls of Type I alone, with the exception of the session from 7:00 to 8:00 A.M. in 1947, the female showed more of this type of vocalization than did the adult male. Offspring # 1 tended to follow the female pattern. The trend to female preponderance in calls of Type I was intensified in the summer of 1948. This observation is in agreement with Carpenter's opinion of relative frequency in Thailand. This investigator believed that the function of these calls was exploratory and defensive as well as protective of territory. In our experience they seemed to be a function of general activity as well as a stimulus to activity of a play-chasing kind.

Type II calls originated more frequently with the male than the female or young in both summers. There was also a tendency for the young to resemble the father more during the second summer than in the earlier period. Carpenter's hypothesis as to function posits a territorial localization purpose. From our data there is little to support such a theory. Type II calls were given by the male and elicited both Type II and I calls from the other animals. Little evidence was obtained of specific situations stimulating the calls. However, with reference to both types, it should be stated that these calls in the wild may be related to the pressure of other neighboring groups.

The feeding period at noon seemed to be the precipitating situation for calls of the third type. According to Carpenter, in the field these single, isolated notes were heard when the group of animals was under observation and served the function of alarm or defensive reactions. The case at the Zoo is not clear, since the feeding hours were also generally the periods of heaviest visitor observation. It is probable that this type of call is most readily conditioned by experience and so comes to be the most circumscribed in point of time of occurrence.

In contrast to calls of Type III, Type IV (VIII

in Carpenter's enumeration) seemed to be an early morning vocalization. It was also found before the evening activity cycle. All three animals gave it in equal amount although in the very late evening the younger animal was more often engaged in these vocalizations.

Other than the above translations from the graph and table, few conclusions could be drawn regarding vocalization. The reliability of the observations is a question that requires an answer. From preliminary work with a second observer, Dr. Daniel Lehrman, the estimated correspondence between 10 observations by each experimenter was above 90%. Automatic recording of vocalizations would have been a more objective technique but was not possible under the conditions of this study.

Comparison with Carpenter's field data shows that there is some difference of significance as a result of restriction of range and population. In the first place, the vocalizations were not as varied as those found in the native habitat. Whereas Carpenter differentiated nine types of calls, we were able to identify only four patterns. In the second place, there was little evidence of defensive and group organizational vocalization at the Zoo. This difference may be explained by the absence of competing gibbon groups in the same habitat. More significant than the differences, was the existence of similarity in observed data. Such resemblances bear on the pervasive effect of biological determinants within the framework of different environmental complexes.

Discussion.— Although the major purpose of the work on which this paper is based was to determine the feasibility of research at a zoological park, especially as it served as a basis of comparison of free-ranging animals with members of the same biological type living in a more restricted territory, some comments can be tentatively advanced along a broader comparative line. The study of mammalian, infra-human sociology has been increasingly developed as field methodology has advanced and the twin restrictive errors of teleology and anthropomorphism have diminished in frequency. Sociometry is supplementary to qualitative description. The main trend in the area has been the insistence of workers that mammalian sociology is basically a matter of ecology, demology and reproductive physiology and psychology. Theories about the origins of group activity in the infra-human primates range from Briffault's dictum that "the causes which give rise to the formation of a group among animals and the bonds which hold such a group together are in every instance manifestations of the reproductive instincts" to

the use of territoriality by Hediger and others as a concept with group cohesive and binding force. In contrast to this theoretical demand for a single etiological factor are the elements elicited by the comparative surveys of primate behavior. Carpenter (1942) stated that "valid investigation of some problems in comparative behavior makes it imperative to study not only animals as wholes but whole animals in a species-adaptive and species-selected environment."

For this type of sociological study, data are now available on the following species: howler monkeys (*Alouatta palliata*), red spider monkeys (*Ateles geoffroyi*), macaques (*Macacus rhesus*, *M. assamensis coolidgei*, *M. mulattus*), gibbons (*Hylobates lar*), orang-utan (*Pongo*), chimpanzee (*Pan*) and gorilla (*G. gorilla gorilla* and *G. gorilla berengei*). For our purposes, five factors have been selected for emphasis: population density, male-female ratio, extent of range, level of sexual excitability and dominance as exhibited in feeding, grooming and sexual behavior. These elements represent the most common items in the field descriptions of the groups cited above. The independent variable under consideration is group organization. Of the species of organisms listed, the range of social organization is from the larger "tribal" to the smaller "familial" relationship, or from the relatively loose aggregation-like mass to the small, fairly well-integrated group. At the tribal end are the baboons, spider and rhesus monkeys while the gibbon typifies the familial organization. Of the five factors that have been held causal by one or more authorities, none seems to be directly related to the continuum of group organizational forms. Species of high population density are found at both extremes, male dominance is exhibited by all species except the gibbon, females predominate in all organized groups except again that of the gibbon. The two most fertile areas for further research seem to be the range or territoriality and sexual excitability. In the gibbon, at least, the relative absence of presenting, mounting and sexual play stands out as a differentiating possibility. Here also the altitude of the range or territory may be important since both the howler and the gibbon use the upper levels of their arboreal environment, in contrast to other species, and are closer in organizational type than the other groups.

Comparison between the free-ranging gibbons and those on Gibbon Island also produces some hypotheses for future exploration. The animals at the Zoo, living relatively free from pressure of other competitive groups of species-mates, seem to be less familial in their group organiza-

tion than those in Thailand, as measured by the amount of inter-individual contacts. With the addition of a new member in the person of a biologically dependent infant, all types of inter-individual contacts increased. This gain in cohesiveness is intensified by the absence of polarization in the form of dominance relationships. Here the restrictive and bond-forming area of sexual interest seems to play a major part.

Summary and Conclusions.—A group of gibbons living under simulated natural conditions was observed over a period of two summers. Initially the group consisted of an adult male and female and an independent young offspring. During the second summer a newly born young was added to the group, the result of second pregnancy of the female. Observations were compared with those which Carpenter made on free-ranging gibbons in Thailand. The following conclusions were drawn:

- (1) Inter-individual contacts of all types increased in frequency during the second summer of observation when the population increased.
- (2) No evidence of polarization (dominance) was observed during either summer.
- (3) No evidence of sexual play was observed.
- (4) Aggression was manifested on few occasions and seems to be at a low level in the group.
- (5) Carpenter's observations on dominance, sex-related vocalization and the absence of sexual play were verified.

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